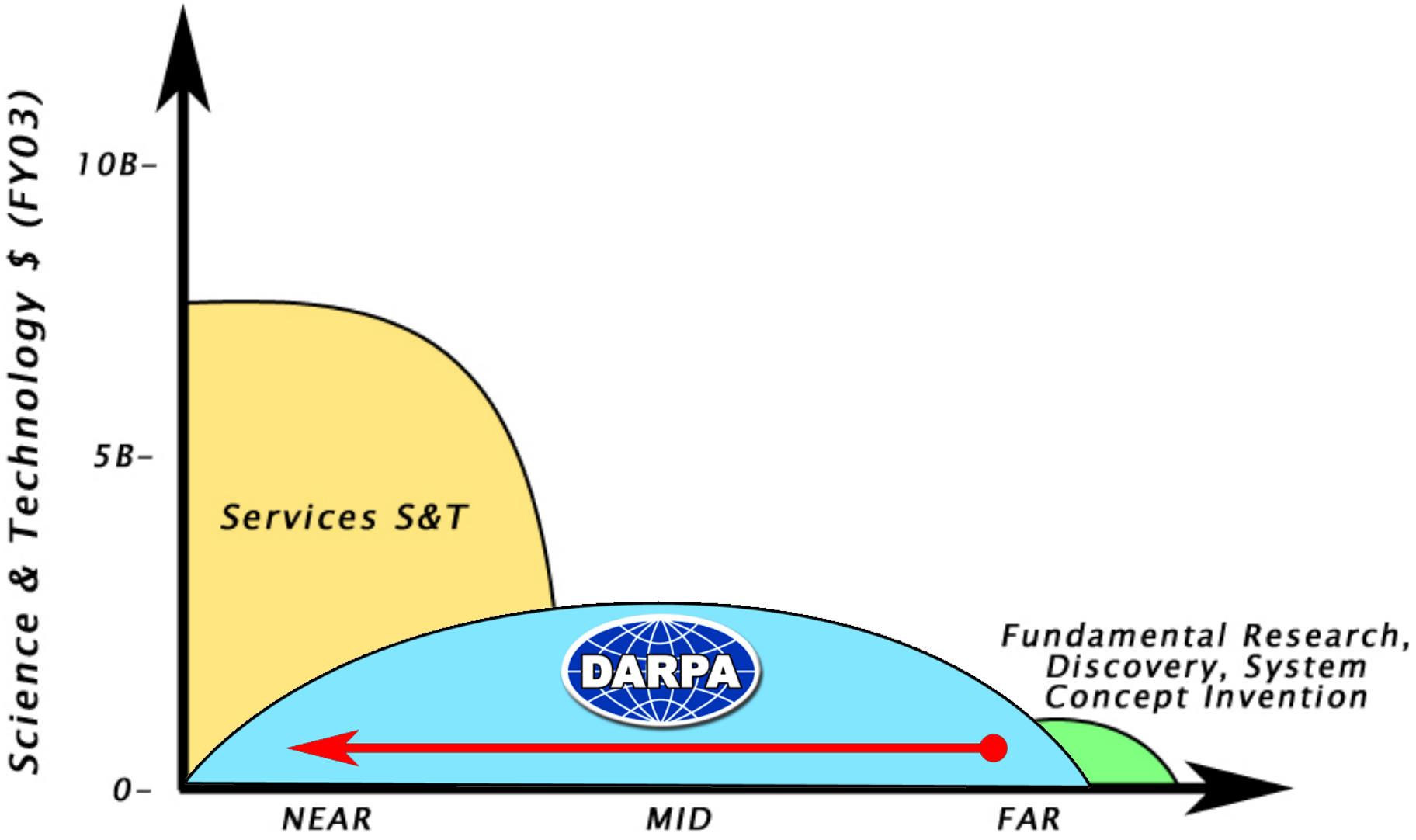
Defense Advanced Research Projects Agency

Bridging the Gap

Dr. Robert F. Leheny
DARPA Deputy Director

DARPA –Bridging the Gap

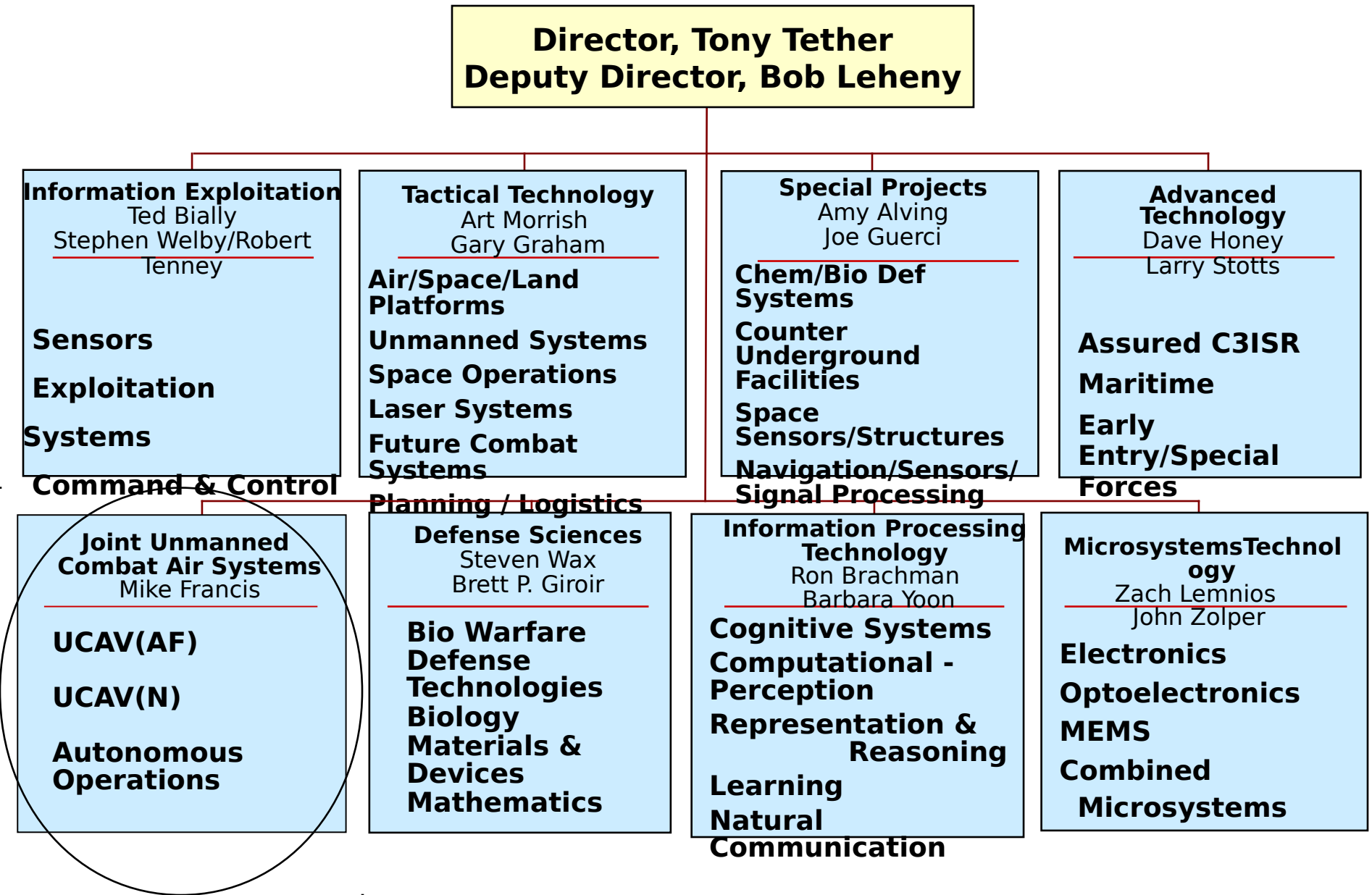


Key Questions

- **What technologies would allow an adversary to surprise the U.S.?**

- **What technologies are needed to ensure U.S. forces will always have new capabilities that surprise adversaries?**

DARPA Organization



Overview

- **What's New**
  - **New Strategic Thrust Area**
    - **Urban Operations**
  - **Quick Reaction Support for Operation Iraqi Freedom**
  - **Program Office**
    - **Joint Unmanned Combat Air System**
  - **Networks**
    - **Increasing Dependence**
- **DARPA Grand Challenge**

DARPA's Strategic Thrusts

Investments Today for Future Capabilities

- **Detection, Precision ID, Tracking, and Destruction of Elusive Surface Targets**
- **Characterization of Underground Structures**
- **Force Multipliers for Urban Area Operations** ***New***
- **Networked Manned & Unmanned Systems**
- **Robust, Secure Self-Forming Tactical Networks**
- **Cognitive Systems**
- **Assured Use of Space**
- **Bio Revolution**

Strategic Thrust Update

New Strategic Thrust Added:

Force Multipliers for Urban Area Operations

- ***Adversaries will fight from urban areas to mitigate U.S. advantages in information technology, stealth, and precision weapons***
- ***Forces required for urban areas operations are greater than those required for operations in open, semi-concealed terrain***
- ***Goal: Find force multiplier capabilities that reduce the amount of forces needed for urban area operations but give U.S. forces the same decisive advantage as exists in open terrain operations***

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Quick Reaction Support

Program	Description	Rapid-Entry Org./POC	Program Status	QRE Status	QRE Schedule
Boomerang	A HMMWV mounted acoustic sensor array for the detection and localization of small arms fire	First Marine Expeditionary Force (I MEF); 1st Cav US Army	Deployed	System requirements discussed with 1MEF - Representatives from 1MEF will attend testing during the week of Jan 19-24	50 units tested, evaluated, delivered 21 Jan 04
Counter-RPG	Detection and defeat technologies for HMMWV mounted defense against RPGs	TBD	PAD has been signed and testing on one candidate system begins in early February	Effort for first defense concept kicked off at Redstone Arsenal 15 Jan 04	Testing will be completed over the next 6 months
IED Wireless Detection & Location	Development of RF methods to detect and locate IEDs	First Marine Expeditionary Force (I MEF) / Col. Otto Weigl	Funded DARPA program for delivery of three fieldable units.	Demonstration of concept in March 04 at Yuma test facilities. Have demonstrated target detection at 40 m (short of 100 m goal).	Field test and demo of concept to be held in March 04. Three fieldable units to be fabricated and delivered in May 04.
Marine Airborne Retransmission System (MARTS)	Wide area 24/7 connectivity/extension of SINCGARS, HAVEQUICK and EPLRS communications networks using an aerostat platform	First Marine Expeditionary Force (1st MEF) / Captain Renee Matthews, USMC, MCWL.	$2M for single demonstration systems. SAIC has begun developing MART subsystems.	Basic system requirements and concept approved by 1st MEF USMC is rounding up GFE for immediate delivery to SAIC.	Demonstration System's proposed delivery to 1st MEF and Iraq is 15 March 2004.

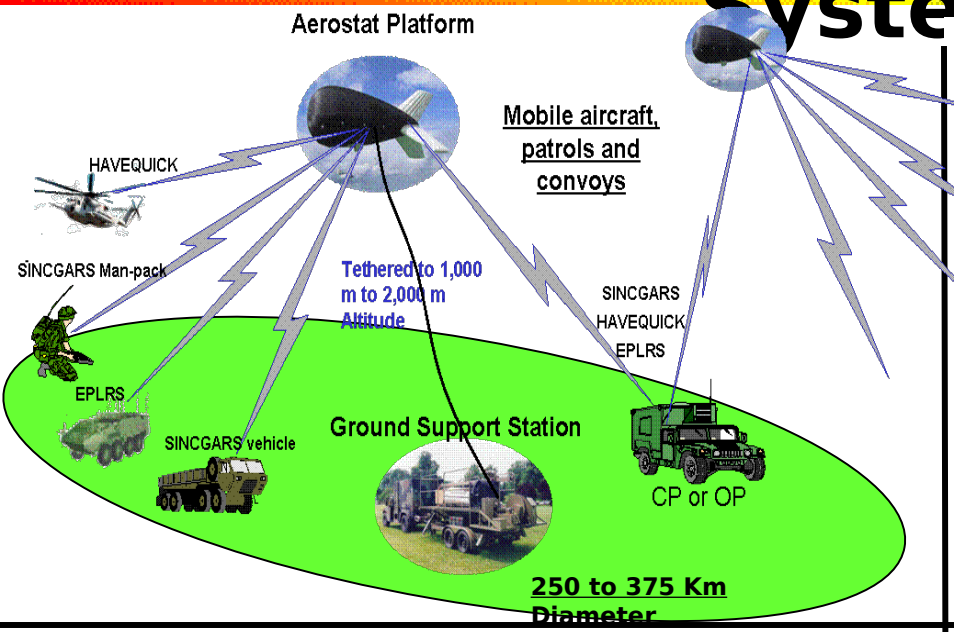
Quick Reaction Support

Program	Description	Rapid-Entry Org./POC	Program Status	QRE Status	QRE Schedule
Command Post of the Future (CPoF)	Distributed, collaborative commander's visualization tool	MG Peter Chiarelli, CG 1st Armored Cavalry Division	DARPA/Army funded extension	Technology in place and used in Division CP for Mission Readiness Exercise	December MRX, March deploy with Division to Iraq for 1 year
Advanced Sensing Technology (AST) Prototype	Phased Development of system to detect impulsive events like gun fire, mortars, etc. and vehicle signature.	US Army, REF / R Kocher	Concept of Principle Demonstration funded within existing program funds. QRE effort is unfunded, awaiting DDRE funding decision.	System in transportable ISO containers; currently testing against gun fire. Test conducted Jan 14-16, 2004 at 29 Palm Marine with gunfire, mortars and vehicle signatures.	Analyzing test data & upgrading system. Demo within 60 Days. QRE effort on hold, Schedule TBD.
Enhanced TIDES Iraq Reconstruction Report (eTIRR)	Produce timely reports affecting troop safety, counterterrorism, stabilization, and reconstruction	CENTCOM, I MEF	Approved by DIRO on 31 Dec	Kickoff meeting held 14 Jan	Two systems (one deployed, one remote) plus daily reports. Initial operation in April.

Boomerang

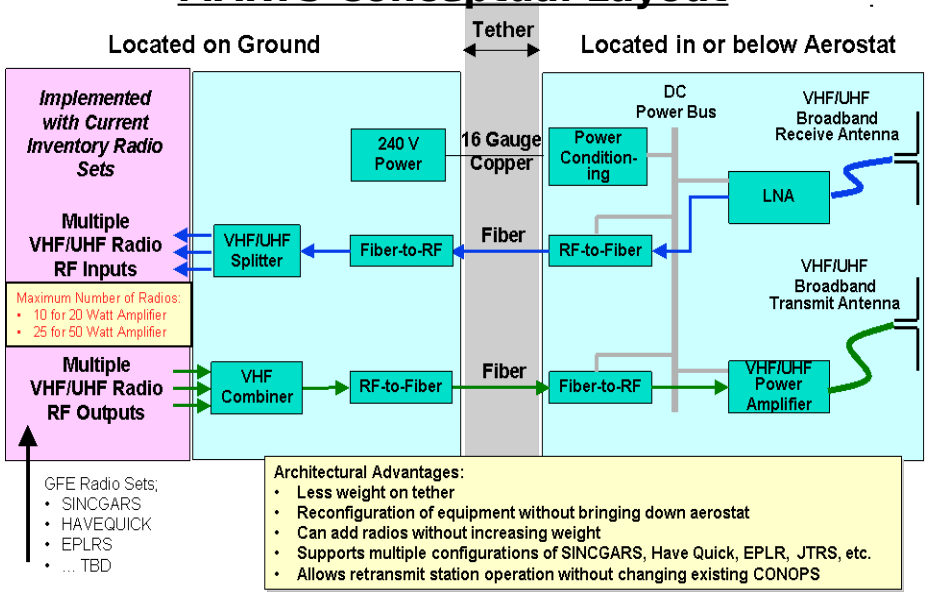
Vehicle-Mounted Shooter Detection And Location System

Marine Airborne Radio-Relay System

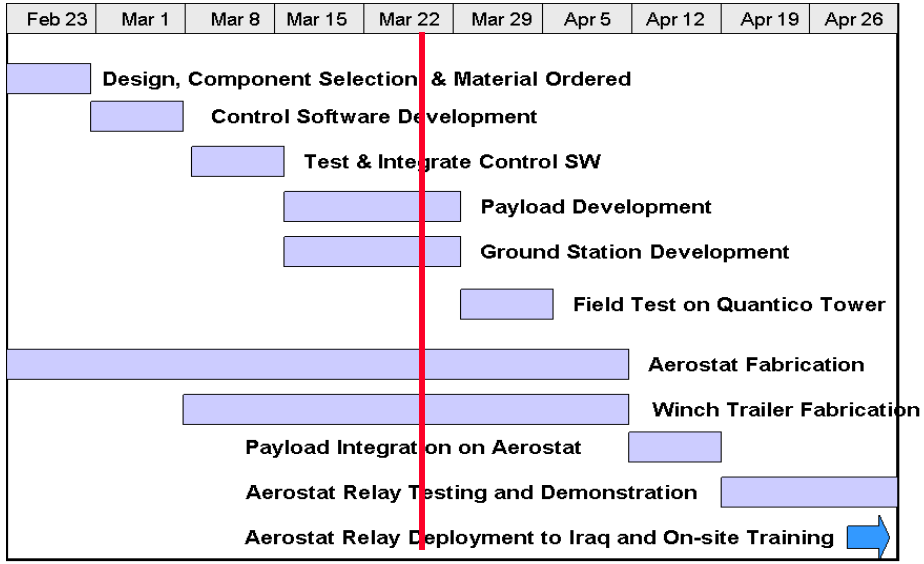


- Problem: Military Operations in Iraqi Freedom are hampered by unreliable, intermittent, communications because of the size of the OP Area and urban structures
- SINCGARS, HAVEQUICK and EPLRS radios are limited to line-of-sight ranges
  - COTS solutions for insertion are not secure, are potentially vulnerable and can be easily intercepted and exploited, e.g., cellular telephones
- Deliverable: An Aerostat Communications Relay that connects 1st MEF SINCGARS, HAVEQUICK and ELPRS networks
  - Leverages existing equipment, Low O&S

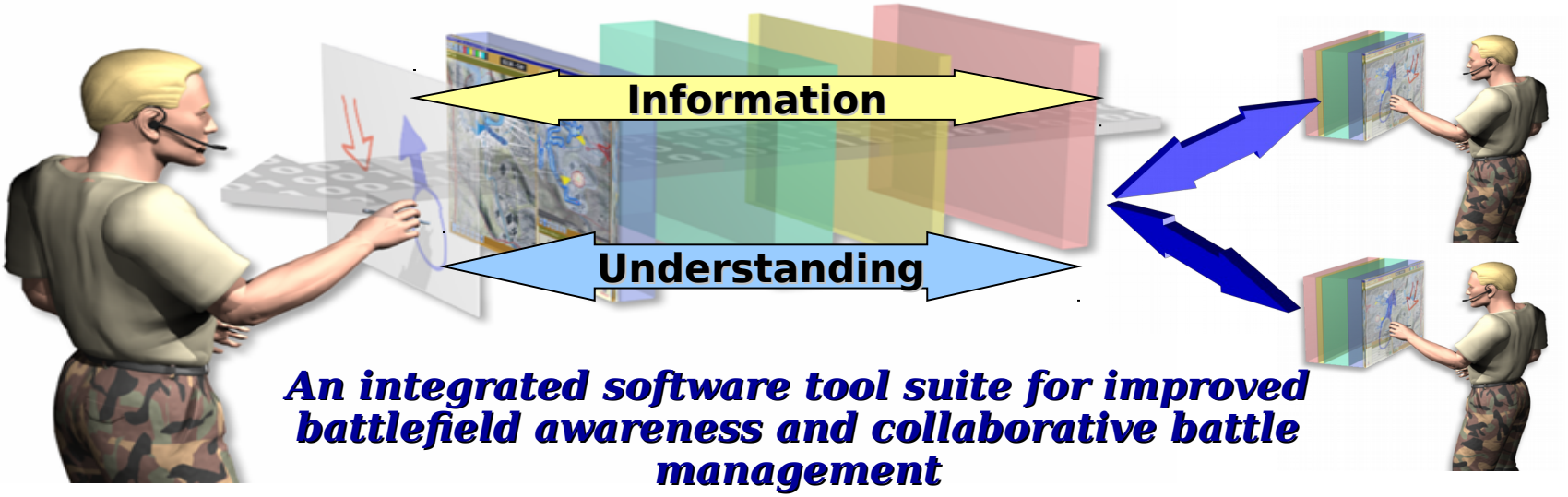
MARTS Conceptual Layout



MARTS Program Schedule



Command Post of the Future

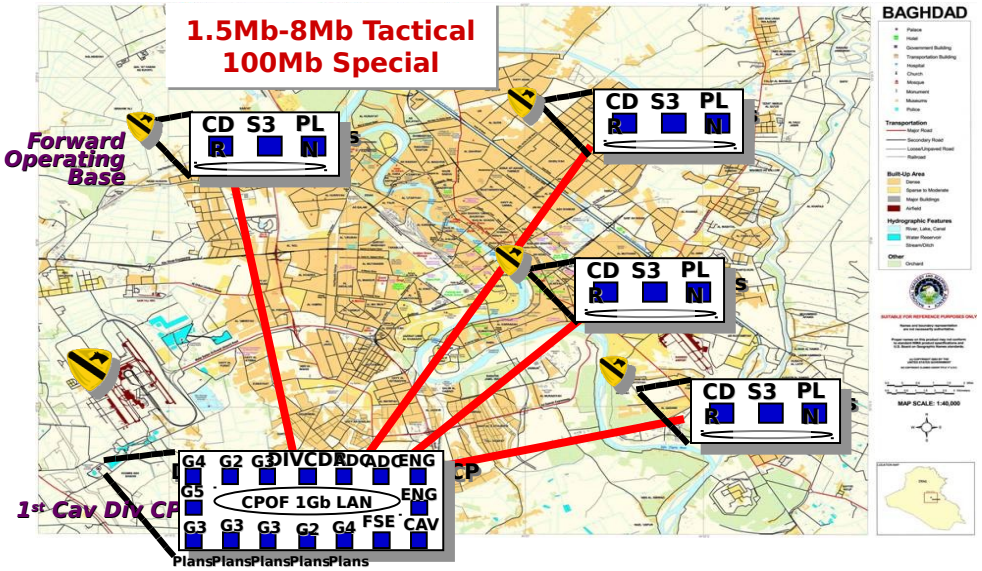


An integrated software tool suite for improved battlefield awareness and collaborative battle management

Distributed collaboration enables the elimination of place-based command posts.

Commanders and staff can be distributed across the battlefield during all phases of tactical operations

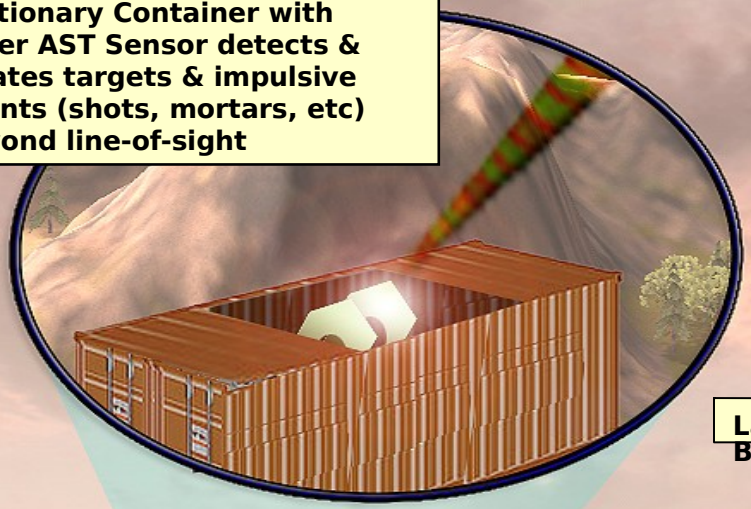
CPoF Configuration for 1st Armored Cavalry Div Baghdad



Advanced Sensing Technology

Stationary Shooter Detection & Location System

Stationary Container with Laser AST Sensor detects & locates targets & impulsive events (shots, mortars, etc) beyond line-of-sight



Advanced Sensing Technologies (AST) Program

- Detect, classify & locate impulse events (gunfire, mortars, explosions) and moving targets

Novel laser system forms large moveable, 2D virtual sensor arrays in lower atmosphere

- Distances 10x greater than our current capabilities
- Challenging environments (behind obstacles & terrain)

Laser Beams

Virtual Array is processed & beamformed to detect & precisely locate target/event

Sniper gunshot

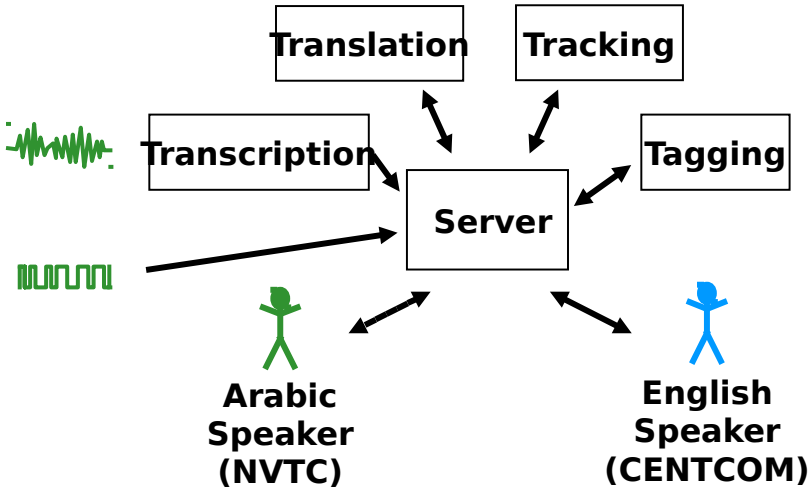
Mortar Attack

Delivery Schedule:

First Field Tests in Container Jan 11
Real Time In Container Tests April 22
CONUS Validation Complete

Enhanced TIDES Iraq Reconstruction Report (eTIRR)

eTIRR



DESCRIPTION / OBJECTIVES / METHODS

- Exploit DARPA-funded advances in transcription, translation, tracking, tagging
- Apply to high value Arabic & English speech & text streams
- Produce timely reports of news and opinion tailored to needs of commanders in Iraq (current TIRR is used by CENTCOM, CPA)

MILITARY IMPACT / SPONSORSHIP

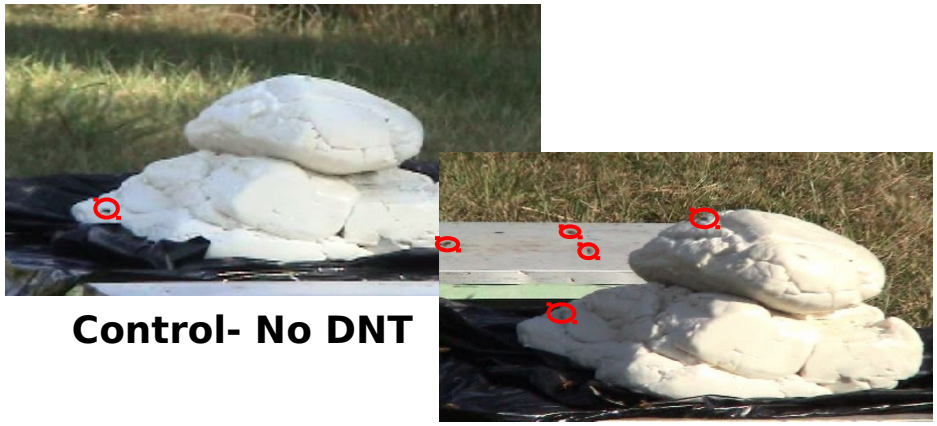
- Quick access to foreign language broadcasts, web sites, wire services
- Timely reports to commanders about developments affecting troop safety, terrorism, stabilization, reconstruction
- Less dependence on scarce linguists
- Immediately for CPA, CENTCOM, I MEF
- Follow-on use in Afghanistan &

BUDGET & SCHEDULE

TASK	2Q FY04	3Q FY04	4Q FY04
Produce steadily improving reports from more sources	4		
Add new translation & transcription capabilities			
Improve functionality, reliability, ease-of-use			
Add new sources & NVTC; deliver to CENTCOM / I MEF			

IED Detection Using Honey Bees

Bee Detection of DNT



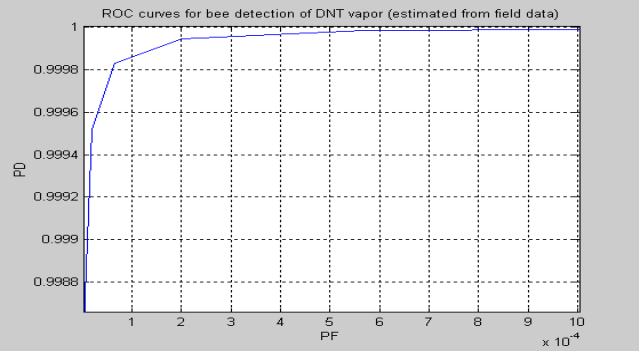
Control- No DNT

DNT

Concept

- Bees can be trained (like dogs) to be sensitive detectors of chemicals (explosives, drugs)
- Demonstrated in sterile environment- bees able to find targets with precision
- Requires:
  - Real-time observation of bee's activity (e.g., image capture)
  - Reinforcement of behavior (preferably with automated system)

Field Tests – Active Collection



- ROC curve for bees finding UXO Pd near 98% with 2.5% false positive and .001% false negative over placed targets
- Similar results from tests with flask and cask UXO (TNT and C4) open and in coolers

Schedule/Status

- Bees in Place, Yuma Testing 1/26/04
- Initial Demonstration Completed 2/4/04
- CENTCOM/NAVEOD Testing 2/6/04
- Results
  - Temperature and Wind Sensitivity Limited Utility
  - Deployment Not Recommended
- Status
  - Investigate approaches to mitigate weather sensitivity
  - Examine value of non-conditioned bees for identifying manufacturing sites

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Unmanned Platforms

Increasingly Complex Systems

EMPHASIS ON PERFORMANCE

EMPHASIS ON AFFORDABILITY

EMPHASIS ON MISSION EFFECTIVENESS & AFFORDABILITY

Level of Autonomy

70's

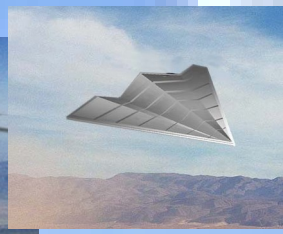
mid 80's

late80's

mid 90's

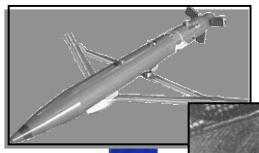
2000

2001



2003

J-UCAS Program



Technology

Vision

Legacy

System Demonstration Program:
Demonstrate J-UCAS technical feasibility, military utility and operational value

Operational Assessment and Effects Based Development
Provide the Services with program options

Demo
Autonomous Ops
Multi-vehicle Ops
Dynamic Tasking

Demo
Survivability
Supportability
Carrier Suit

Op Ass't
SEAD
Surveillance
EA
Strike

- Common Operating System
- Common Elements
  - Sensors
  - Weapons
  - Communications

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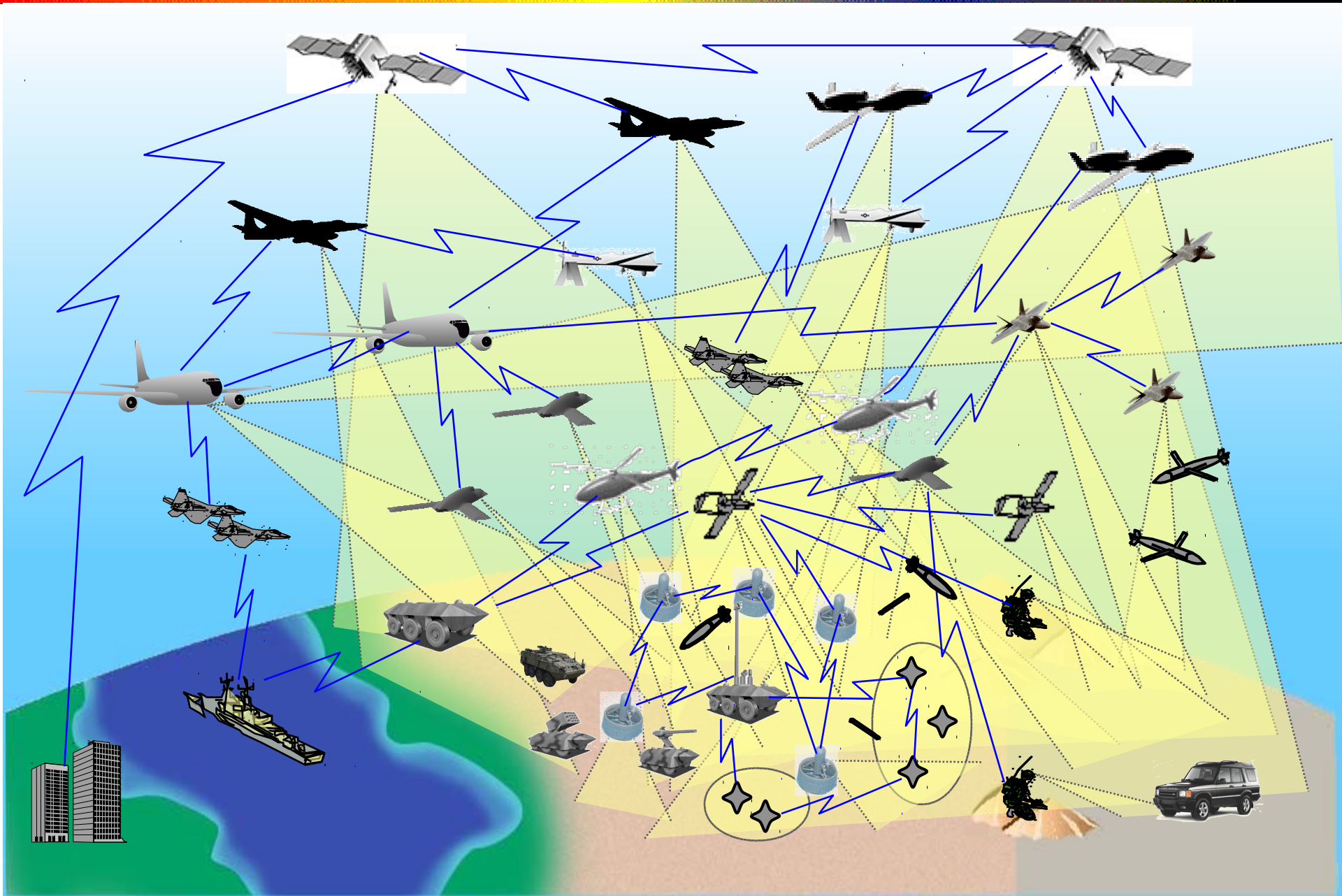
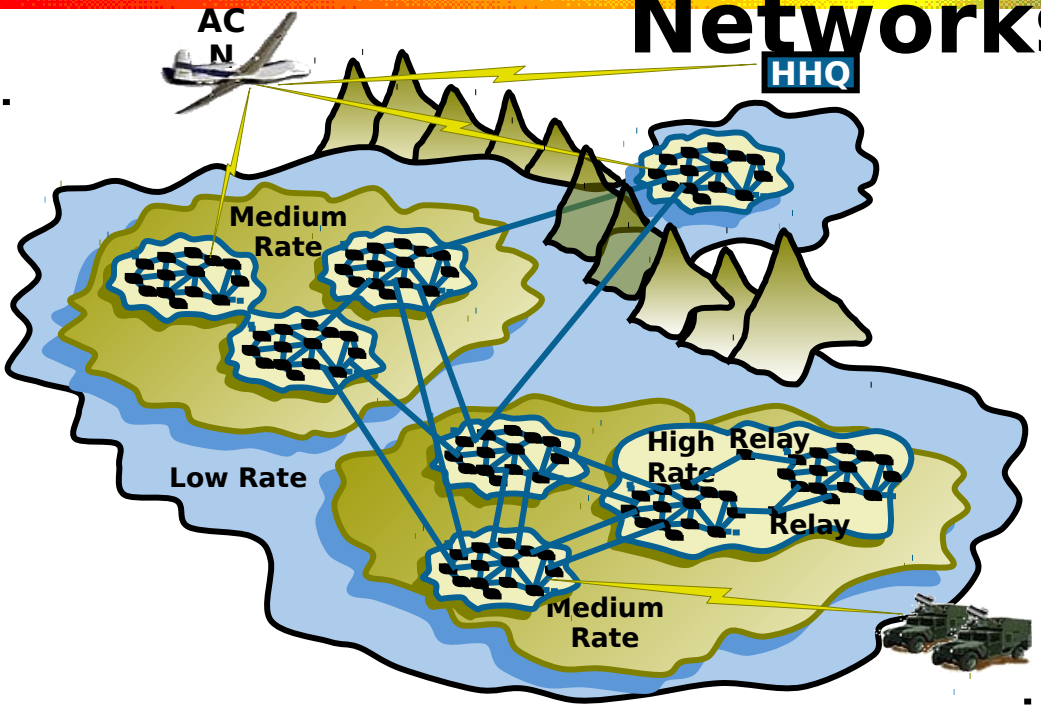
Networked Operations



Robust, Secure Self-Forming Networks



Unparalleled Communications

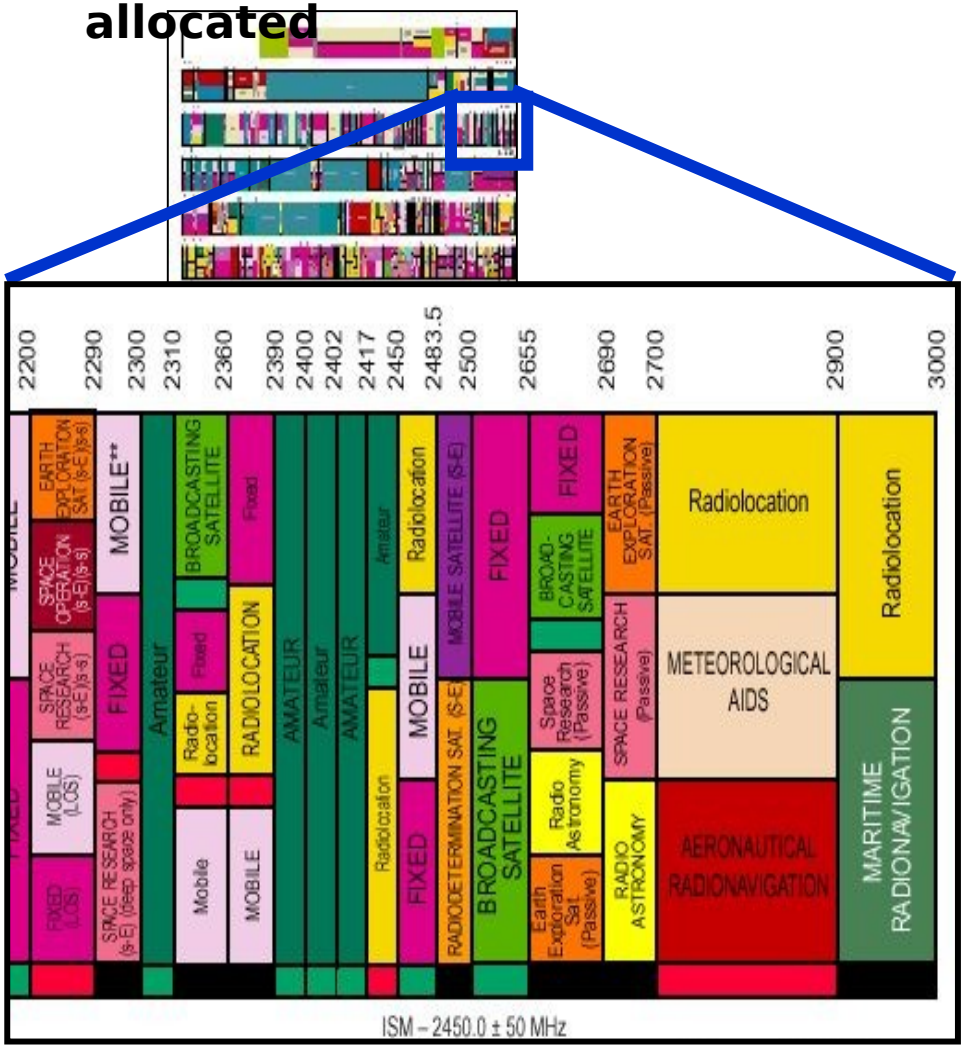
- Connectivity guaranteed in any environment, at distances and data rates never before available
- Minimum or no fixed infrastructure

Assured Networking

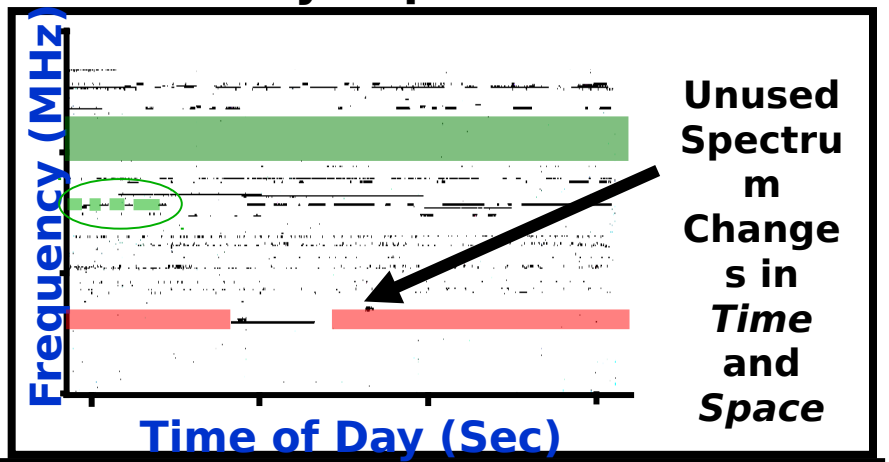
- Building trustworthy systems from the ground up
- Networks to be intelligent, self-sensing & self-healing to detect and respond to attacks in real-time

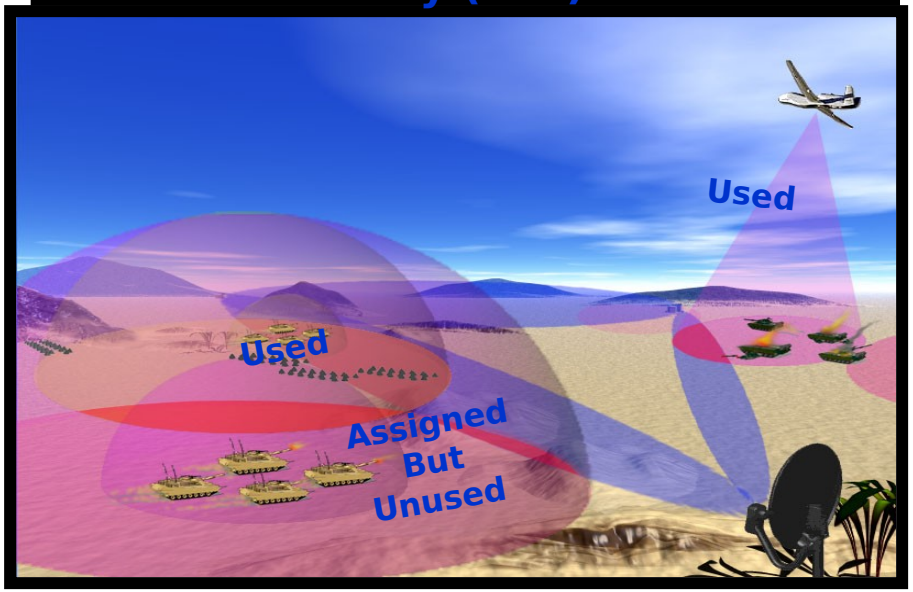
neXt Generation (XG) Communication

TODAY: **Spectrum statically allocated**



FUTURE : **Dynamically allocating spectrum in frequency, space, and time may improve utilization**





Nanotechnology

Nano-Mechanical Array Signal Processing

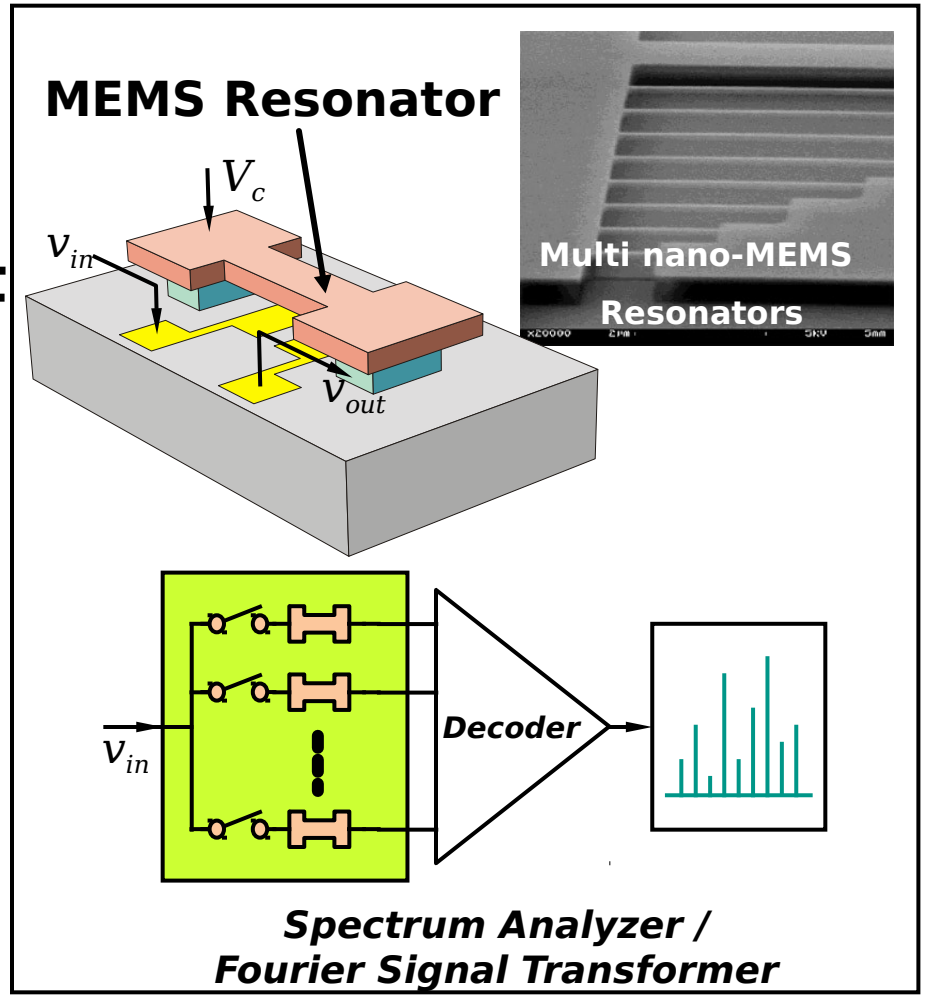
Create arrays of precision, nano MEMS structures for

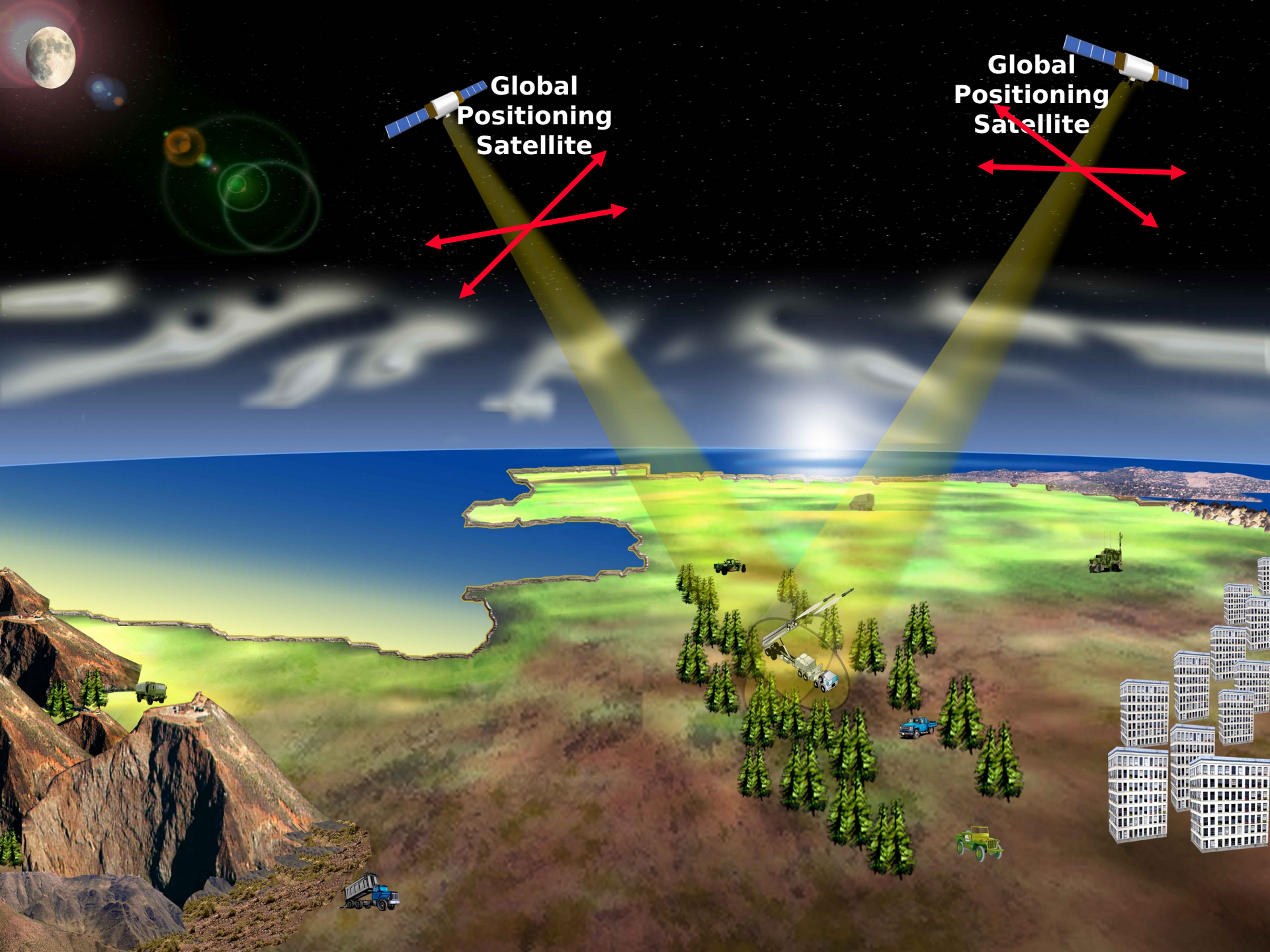
RF-signal processing that achieve:

>100X reduction in size

>100X reduction in power consumption (300 mW to <3 mW)

>10X improvement in RF performance (spectral

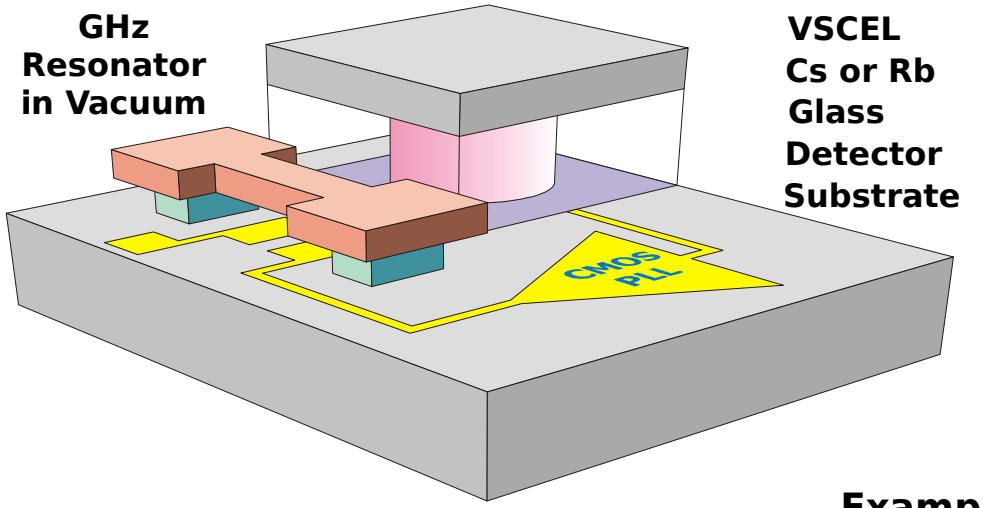



Global
Positioning
Satellite
Global
Positioning
Satellite

Nanotechnology for Networks

Chip-Scale Atomic Clock

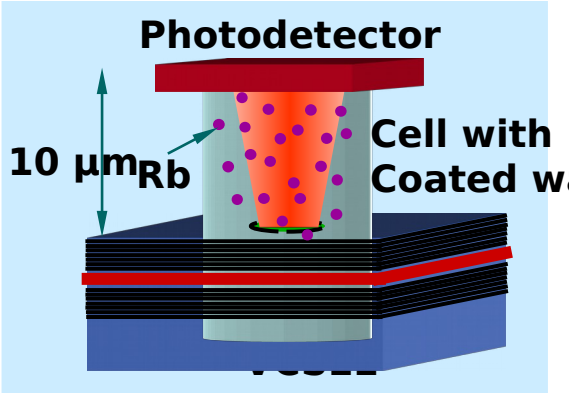
Ultra-miniaturized, low-power, atomic time and frequency reference units



>200X reduction in size

>300X reduction in power

(±1×10^{-11} accuracy ⇒ <1μs/day)



Atomic Absorption Cell

Example of Use: Radio System (SINCGARS)

Clock accuracy of 1 × 10^{-11} ⇒ 16-hour resynch interval or radio silence

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The DARPA Grand Challenge

200+ miles of some of the toughest terrain in the world

The best autonomous robotic vehicles America can build

$1 million cash prize

13 March 2004

Winner takes all

Grand Challenge

in association with SCORE INTERNATIONAL OFF-ROAD RACING

Vista Engineering
Carson, WA
The Prodigies
Olympia, WA

Viva Las Vegas
Portland, OR

The Blue Team
Berkeley, CA
De Anza Robotics Team
Richmond, CA
Digital Auto Drive
Morgan Hill, CA
Team Overbot
Redwood City, CA
Team Mackenzie
Salinas, CA

Team Zingerbot
Colorado Springs, CO

Team Phantasm
Ballwin, MO

The ION Team
Oshkosh, WI

Team AV Andrea Morgan
Team AV Sydney Bristow
Team AV Wendy Darling
Traverse City, MI

Team LoGHIQ
Walden, NY

The Red Team
Pittsburgh, PA

Armani
Dayton, MD

Virginia Tech
Blacksburg, VA
Team ENSCO
Springfield, VA

Insight Racing
Cary, NC

Desert II
Atascadero, CA
Axion Racing
Westlake Village, CA
Team Spirit of Las Vegas
Edwards, CA
A.I. Motorvators
Los Angeles, CA
"R" Junk Works
Palmdale, CA
Palos Verdes High School
Road Warriors
Palos Verdes Estates, CA
Team Caltech &
The Golem Group
Pasadena, CA

Dark Horse
Las Vegas, NV

Rob Meyer Productions
Tucson, AZ

Team One Blue &
Team One Green
Carrollton, TX

Team CajunBot
CajunBot II
CajunBot III
Lafayette, LA

Center for Intelligent Machines
and Robotics (CIMAR)
Gainesville, FL

Terra Engineering
Rancho Palos Verdes, CA
The Road**Runners**
San Dimas, CA
CyberRider
San Juan Capistrano, CA
Rover Systems
Santa Ana, CA
Santa Barbara Grand
Challenge Team
Santa Barbara, CA
Team SARA
Tehachapi, CA
SciAutonics I & II
Thousand Oaks, CA

Team Arctic Tortoise
Fairbanks, AK

Grand Challenge – March 13, 2004

The Grand! Challenge

Opportunity

DARPA Always Interested in Good Ideas

- **Solicitations: www.darpa.mil**
- **Talk to DARPA Program Managers**
- **Become a DARPA Program Manager**

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